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(19)

(54) MANUFACTURE OF SEMIFINISHED PRODUCTS OF FIBER-REINFORCED THERMOPLASTICS MATERIAL

(71) We, BASF AKTIENGESELLSCHAFT, a German Joint Stock Company, of 6700 Ludwigshafen, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a continuous process for the manufacture of a semifinished product of fiber-reinforced thermoplastics material.

German Published Application 1,454,988 describes a process for the manufacture of shaped articles in which a semifinished product of fiber-reinforced thermoplastics material is heated until plastic flow occurs and is then shaped. This is a simple method of producing sturdy, heavy-duty shaped articles for use, for example in automobile construction or the manufacture of furniture. The semifinished product used in this process consists of flat webs, boards or panels which may be produced by coating textile webs, e.g. glass fiber mats, with molten plastics material by means of an extruder. However, this simple process does not provide completely satisfactory impregnation of the fiber mat with the molten thermoplastics material, even when the fiber mat is coated on each face. Cavities form in the semifinished product, and this leads to a marked reduction in the strength of the end products.

Furthermore, these phenomena are not completely obviated when loose glass fiber mats are laminated or impregnated with a thermoplastics material and then hot-pressed, as proposed in East German Patent 20,549 or West German Published Application 2,007,370. Also, when this process is carried out continuously, the hot semifinished product must be cooled in a separate operation following compression. This is a relatively long procedure and greatly prolongs the cycle times.

Another way of manufacturing semifinished products of fiber-reinforced thermoplastics is described in German Published Application 2,054,471. In that Application, the fiber mat was coated with a thermoplastics dispersion. The water was then evaporated and the semifinished product heated until the plastics material softens. Although this method produces cavity-free material, it is very costly on account of the complicated drying equipment which must be used in order to remove the water completely.

The present invention seeks to provide a simple and fast process for the continuous manufacture of a semifinished product of fiber-reinforced thermoplastics material, from which shaped articles having high strength may be produced.

According to the invention there is provided a process for the continuous manufacture of a semifinished product of fiber-reinforced thermoplastics material, wherein one or more (textile web) structures preheated to from 150° to 300°C are brought into contact with a melt of a (thermoplastics material) and the components are then pressed together in a compression zone and simultaneously (cooled under pressure.)

A wide variety of (thermoplastics materials) is suitable for our process, for example olefin polymers such as polyethylene and polypropylene; styrene polymers such as polystyrene and copolymers of styrene with up to 50% by weight of acrylonitrile, α-methylstyrene, maleic anhydride or methyl methacrylate, and also rubber-modified styrene polymers, preferably those containing from 2 to 25% by weight of a butadiene rubber; chlorine-containing polymers such as polyvinyl chloride, polyvinylidene chloride and chlorinated polyolefins; polyamides; polymethyl methacrylate; polyesters of terephthalic acid and saturated diols; polycarbonates; and mixtures of said polymers.

The thermoplastic polymer(s) may contain conventional additives such a fillers, pigments,

dyes, antistatic agents, stabilizers, flameproofers and lubricants.

Suitable textile web structures include nonwoven fabrics and woven fabrics, e.g. felts or mats, made of glass fibers, carbon fibers, plastics fibers or asbestos. To improve the cohesion of the fibers in the web structure, it is advantageous to coat them with conventional plastics binders. Glass fibers may be treated with conventional sizes containing, for example, an adhesion promoter based on silane or chromium. We prefer to use loose glass fiber mats weighing from 150 to 1,200 and in particular from 250 to 1,200 g/m^2, which may be additionally covered with surface webs weighing from 30 to 60 g/m^2.

The weight ratio of thermoplastics material to textile web structure is suitably selected such that the semifinished product contains from 10 to 70% and preferably from 20 to 60% by weight of fibers. The molten plastics material may be used to impregnate a single mat or a number of superimposed mats.

The essential feature of the invention is that the textile web structure(s) are heated to the working temperature before being combined with the molten plastics material. This may be effected, for example, by heating them with infrared radiators, passing them through an oven or passing them over hot rollers. The working temperature is from 150°C to 300°C and preferably from 200° to 280°C. If the web structure(s) are not preheated, less strong shaped articles are produced when the semifinished product is shaped.

The temperature of the molten plastics material is governed by the softening range and decomposition temperatures of the thermoplastics used. It is generally from 170° to 300°C. The melt should be as mobile as possible. In the case of polyolefins, the viscosity of the melt at the working temperature should preferably be below 5×10^5 centipoise and below 1×10^6 centipoise in the case of styrene polymers and below 1×10^5 centipoise in the case of polyamides. The melt is conveniently metered from an extruder having a sheeting die.

When the molten material is brought into contact with the textile web structure or structures, there is only partial penetration of the melt into the mat. However, compression of the hot assembly ensures that the mat is completely impregnated and that air is excluded therefrom. Such compression suitably takes place on continuously operating belts or rollers. The residence time in the compression zone should be relatively long, since compression and cooling must be simultaneous. Thus it is useless to employ a single pair of rollers for example. However, suitable compression means consist of a drum partially surrounded by an endless belt as described in Example 2 or a chain as described in Example 3 of German Published Application 1,454,988 or an endless pressure belt as described in Example 7 of East German Patent 20,549.

In the compression zone, the molten plastics material is pressed into close contact with the textile web structure. The applied pressure is advantageously from 0.1 to 20 bars and preferably from 1 to 15 bars. This treatment generally compresses the textile web structure or structures, for example to a fifth of their original thickness in the case of glass fiber mats. The pressure elements are not generally heated, and consequently the hot semifinished product is cooled in the compression zone. Such cooling may be accelerated by cooling said elements. The residence time of the components of the semifinished product in the compression zone is generally from 10 seconds to 10 minutes and preferably from 20 seconds to 3 minutes.

The semifinished product thus produced generally has a thickness of from 0.3 to 10 mm and preferably from 0.5 to 5 mm. It may be cut or, in the case of thin materials, wound onto a core. It may be further processed either immediately or after storage. Such further processing is advantageously carried out by the process described in German Published Application 1,454,988 and leads to finished products such as corrugated panels, automobile body parts, containers, facade panels or parts of furniture.

EXAMPLE 1

The process was carried out using an apparatus as shown in Figure 1 of the accompanying drawings. Two endless glass fiber mats 4 each having a thickness of 0.5 cm and weighing 900 g/m^2 are heated to about 230°C by means of infrared radiators 5. They pass over two heated rollers 2 to a compression zone. An approximately 1.5 mm thick curtain of polypropylene having a temperature of 230°C is extruded into the nip between the two mats from a sheeting die 6. The melt viscosity of the polypropylene is 2×10^5 centipoise. In the compression zone, the glass fiber mats and the molten polypropylene are pressed together under a pressure of approximately 5 bars by means of endless steel belts 1. The residence time in the compression zone is 2 minutes. The semifinished product X leaves the compression zone via cooled rollers 3. Its temperature is then 60°C and its thickness 2.8 mm. The glass fiber content of the semifinished product is 48% by weight. Its tensile strength is 1,100 kg/cm^2, as measured according to German Standard DIN 53,455. Its modulus of elasticity is 80,000 kg/cm^2, as measured according to DIN 53,457. The semifinished product has approximately the same rigidity and strength as 0.8

thick steel plate. This represents a weight saving of 37%.

In a control experiment, the glass fiber mats were not preheated. In this case, the semifinished product had a tensile strength of only 850 kg/cm².

EXAMPLE

A reinforced thermoplastic semifinished product is manufactured using the apparatus shown diagrammatically in Figure 2 of the accompanying drawings. This apparatus consists of a large drum 11 having cooling means and against which an endless steel belt 12 is pressed by means of pressure rolls 13 and a tensioning roll 14. Two glass fiber mats 16 each preheated by an infrared radiator 15 and weighing 300 g/m² are drawn through the gap between the drum and the belt, and molten polyamide (nylon 6) is extruded through a sheeting die 17 at about 260°C into the nip between said mats. On leaving the compression zone the semifinished product X has a temperature of only 70°C and can be wound onto a core 18. It has a thickness of about 0.8 mm and a glass content of about 50% by weight The tensile strength is over 2,000 kg/cm² and its modulus of elasticity is found to be 110,000 kg/cm².

EXAMPLE 3

Using the apparatus shown in Figure 1, two glass mats each having a thickness of 0.3 cm and weighing 450 g/m² are heated to 235°C. A molten copolymer of styrene and acrylonitrile containing 35% of acrylonitrile is extruded at 235°C in the form of a curtain having a thickness of 1.4 mm. The pressure belt is also heated and is cooled when a pressure of about 10 bars is applied over a residence time of 1 minute. The resulting panel has a thickness of about 1.8 mm and a glass content of 40%. It is almost transparent and has a modulus of elasticity of 90,000 kg/cm² and a tensile strength of 950 kg/cm².

WHAT WE CLAIM IS:—

1. A process for the continuous manufacture of a semifinished product of fiber-reinforced thermoplastics material, wherein one or more textile web structures preheated to from 150° to 300°C are brought into contact with a melt of a thermoplastics material and the components are then pressed together in a compression zone and simultaneously cooled under pressure.

2. A process as claimed in claim 1, wherein one or more glass fiber mats are used as the textile web structure(s).

3. A process as claimed in claim 1 or 2, wherein the melt of the thermoplastics material has a temperature of from 170° to 300°C when brought into contact with the textile web structure(s).

4. A process as claimed in any of claims 1 to 3, wherein the textile web structure(s) and the thermoplastics material are pressed together under a pressure of from 0.1 to 10 bars.

5. A process as claimed in any of claims 1 to 4, wherein the thermoplastics material used is an olefin polymer, a styrene polymer, a polyamide, a polyvinyl chloride, polymethyl methacrylate, a polyester, a polycarbonate or a mixture of two or more thereof.

6. A process as claimed in any of claims 1 to 4, wherein the thermoplastics material used is a polyolefin having a melt viscosity at the processing temperature of less than 5×10^5 centipoise.

7. A process as claimed in any of claims 1 to 4, wherein the thermoplastics material used is a styrene polymer having a melt viscosity at the processing temperature of less than 1×10^6 centipoise.

8. A process as claimed in any of claims 1 to 4, wherein the thermoplastics material used is a polyamide having a melt viscosity at the processing temperature of less than 1×10^5 centipoise.

9. A process as claimed in any of claims 2 to 8, wherein one or more loose glass fiber mats each weighing from 150 to 1,200 g/m² are used as the textile web structure(s).

10. A process as claimed in any of claims 1 to 9, wherein the weight ratio of thermoplastics material to textile web structure is such that the semifinished product thus produced contains from 10 to 70% by weight of fibers.

11. A process as claimed in any of claims 1 to 10, wherein the residence time of the components of the semifinished product in the compression zone is from 10 seconds to 10 minutes.

12. A process as claimed in any of claims 1 to 11, wherein two textile web structures are brought into contact with an intervening melt of a thermoplastics material and the assembly is then pressed together and cooled in the compression zone.

13. A process for the continuous manufacture of a semifinished product of a fiber-reinforced thermoplastics material carried out substantially as described with reference to the foregoing Examples.

14. Semifinished products of fiber-reinforced thermoplastics materials when manu-

factured by a process as claimed in any of claims 1 to 13.

15. Corrugated panels, automobile body parts, containers, facade panels and furniture parts made from semifinished products claimed in claim 14 by further processing.

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1451824 1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale

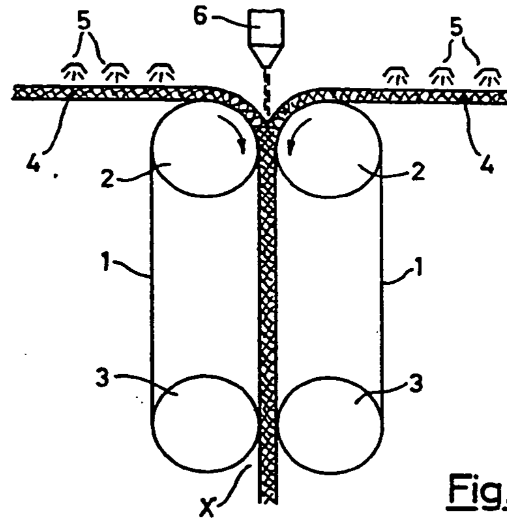

Fig.1

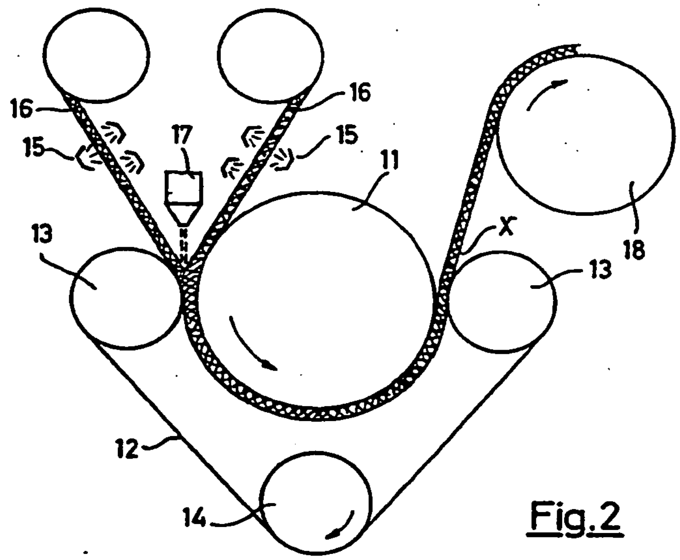

Fig.2